2. Remarks

Claim Rejections – 35 USC § 102

Claims 25, 28-33, 38, 39, 46 and 47 were rejected under 35 U.S.C. 102(b) as being anticipated by Douglas et al (US 4,023,961). The applicants respectfully traverse this rejection.

Claims 25, 28 and 29 in the present invention relate to single-phase, mixed-metal, metal oxide particulate materials. The present invention teaches new art on how to prepare single-phase oxide materials comprising multiple specific metals. For example, Example 1 of the present invention teaches the preparation of single-phase $Cu_2In_2O_5$.

In the case of mixed-metal materials comprising oxygen, Douglas et al teach the formation of multi-phase materials comprising a noble metal and a metal oxide, or comprising multiple metal oxides in a metal oxide / metal oxide composite (column 2, lines 9-10 and 28-31). Multinary composite materials comprising a metal oxide prepared according to Douglas et al have multiple phases (column 7, lines 11-17). Douglas et al disclose no single-phase, mixed-metal, oxide materials.

The Final Office Action (FOA) on page 4 in the first full paragraph states the position that, in light of the teachings of the present invention, a solution of silver and cadmium nitrates processed in a flame or hot air at 550°C would yield a single-phase powder; however, Douglas et al contradict this position, referring to the resulting composite powder as a silver-metal oxide powder (column 9, line 64), i.e. a multi-phase material comprising cadmium oxide and silver metal. The fact that Douglas et al report multi-phase metal / metal oxide materials under preparation conditions similar to those that the present invention teaches can be used to form single-phase materials underscores the significant differences in the chemistries of the specific noble metals disclosed by Douglas et al (Ag, Au, Pt and Pd) and the specific metals and processing conditions disclosed in the present invention.

Given that claims 25, 28 and 29 as presently amended relate explicitly to the preparation of single-phase, mixed-metal, metal oxide particulate materials and that Douglas et al teach that similar methods of preparing mixed-metal materials comprising a metal oxide lead invariably to multi-phase materials, the applicants respectfully submit that Douglas et al teach away from the present invention and that claims 25, 28 and 29 as amended are patentable over the cited art and should be allowed.

Claims 30 through 33 of the present invention relate to the preparation of mixed-metal particles comprising a non-oxide phase. These claims as presently amended teach that materials comprising Cu and In and/or Ga, or comprising In and Sn can be prepared as multi-phase particles comprising a non-oxide phase, or as multinary metallic particles. For example, Example 3 of the present invention discloses the preparation of multi-phase, mixed-metal particles comprising copper metal and indium oxide, and particles comprising Cu and In metal, depending on the environment (e.g. gaseous ambient) in which the materials are prepared.

Douglas et al teach that for specific noble metals (i.e. Ag, Au, Pt and Pd [see column 2, lines 20-22]) one can use aerosol pyrolysis to prepare particles comprising a metal phase by reacting the aerosol with a liquid reducing agent (see for example column 3, line 7) or by

thermal decomposition via a gas flame, hot air or other heating methods (column 9, lines 53-62). All of the examples disclosed by Douglas et al of materials comprising a non-oxide phase involve one or more of the four listed noble metals, and all of the methods disclosed by Douglas et al in which these noble metals are used result in materials comprising a non-oxide phase. This stands in sharp contrast to the teachings of the present invention in which a solution comprising, for example, Cu and In can be made to yield a single-phase multinary oxide material (i.e. $Cu_2In_2O_5$), a multi-phase material comprising multiple oxides (e.g. CuO-In_2O_3), or a multi-phase material comprising a non-oxide phase (e.g. Cu-In_2O_3) depending on the preparation conditions. The key differences are the chemistry of the specific metals and the use in the present invention of specific processing conditions to obtain specific particle characteristics.

The differences between the materials taught by Douglas et al and those taught in the present invention are evident in the scientific literature. Douglas et al teach that a metallic phase can be achieved using specific noble metals, i.e. Au, Ag, Pt and Pd. Noble metals are resistant to oxidation in contrast to base metals (e.g. Cu) that oxidize when heated in air; noble metals are easily reduced and occur naturally in their metallic elemental forms. Base metals oxidize more readily; for example, copper forms pink Cu_2O in air below 100°C and rapidly forms black CuO above 300°C. Reactant solutions comprising Cu, In, Ga, or Sn readily form metal oxides when heated appreciably in oxidizing conditions. For example, indium nitrate pyrolyzed in air at 400°C forms In_2O_3 (see H. Schroeder in Optica Acta, July 1962, vol 9, pages 249-254); a solution of indium and copper nitrates spray pyrolyzed in air at 150°C forms a copper indium oxide film (M. Beck and M. Cocivera, Thin Solid Films 272 (1996) 71-82); and $SnCl_4$ sprayed in air yields tin oxide at temperatures as low as 150°C (M. Miki-Yoshida and E. Andrade, Thin Solid Films 224 (1993) 87-96). In contrast, oxides of Au spontaneously decompose to metallic Au at room temperature, and Pt is sufficiently resistant to oxidation that it can used as a crucible in air at 1000°C to prepare ceramics (L. Kassab et al., Optics Express 6 (2000) p. 104). The particular differences between copper and silver are evident in, for example, the use of thin silver coatings to mitigate the deleterious susceptibility of copper to oxidation; Xu et al report using electroless silver coatings to reduce the oxidation susceptibility of fine copper powder (X. Xu et al, Materials Letters 57 (2003) 3987-3991).

The teachings of Douglas et al vis-à-vis particles comprising a non-oxide phase are limited in their utility to noble metals. One skilled in the art attempting to apply the teachings of Douglas et al to the metals disclosed by the present invention would not produce materials comprising a non-oxide phase, rather one would produce only oxide phases. The unique teachings of the present invention are needed with the claimed metals to prepare materials with the specific advantageous properties, i.e. submicron particles comprising a non-oxide phase.

Given that claims 30-33 as presently amended relate to specific metals that are in their nature quite different from the metals disclosed by Douglas et al and that these differences in metal natures yield sharply different results when processed by the teachings of Douglas et al and the teachings of the present invention, the applicants respectfully submit that Douglas et al teach away from the present invention and that claims 30-33 as amended are patentable over the cited art and should be allowed.

Claims 38 and 39 of the present invention relate to the preparation of mixed-metal particles comprising multiple oxide phases by preparing droplets of a reactant solution and heating the droplets in a non-oxidizing atmosphere or in a substantially inert atmosphere. The present invention teaches that proper selection of the heating atmosphere is essential in producing

specific advantageous particle characteristics. For example, Examples 1-3 of the present invention disclose that identical reactant solutions can be made to yield single-phase oxides, multi-phase oxides, multi-phase metal / oxide composites, or multinary metallic particles with the proper selection of heating conditions.

Douglas et al teach reacting droplets with a liquid reducing agent (column 3, lines 6-7), a precipitating medium (column 6, lines 46-49), or thermal decomposition in gas flame (column 2, lines 57-59) or hot air (column 9, lines 59-60). In all cases where the reactant solutions of Douglas et al comprise one of four specific noble metals, the resulting particles comprise a metallic noble metal phase; and in all cases where the reactant solutions of Douglas et al comprise other specific listed metals including copper, indium and tin (column 2, lines 22-25) the resulting particles comprise those metals in separate single-metal oxide phases (see for example column 9, lines 15-38 where CuO/CdO and CuO/ZnO composite materials are disclosed). Douglas et al teach away from the present invention by disclosing data that suggests that mixed-metal reactant solutions reacted under a variety of conditions lead invariably to metal / oxide or oxide / oxide materials depending on whether one or more specific noble metals are present or whether one or more specific base metals are present. One skilled in the art would not be lead by the teachings of Douglas et al to the unanticipated result disclosed in the present invention that for reactant solutions of particular base metals the use of a non-oxidizing or substantially inert heating atmosphere yields particles with advantageous characteristics.

Given that claims 38 and 39 as presently amended teach the advantages of using certain processing atmospheres to achieve specific particle characteristics when producing particles comprising certain metals and that the disclosures of Douglas et al teach away from the processing avenues of the present invention, the applicants respectfully submit that Douglas et al teach away from the present invention and that claims 38-39 as amended are patentable over the cited art and should be allowed.

Claims 46 and 47 of the present invention relate to the preparation of multi-phase, mixed-metal particles comprising two or more of Cu, In and Ga by preparing droplets of a reactant solution and heating the droplets in a substantially inert atmosphere or in a reducing atmosphere. The distinctions between the present invention and Douglas et al parallel those described above for claims 38 and 39.

Given that claims 46 and 47 as presently amended teach the advantages of using certain processing atmospheres to achieve specific particle characteristics when producing particles comprising certain metals and that the disclosures of Douglas et al teach away from the processing avenues of the present invention, the applicants respectfully submit that Douglas et al teach away from the present invention and that claims 46-47 as amended are patentable over the cited art and should be allowed.

The new art disclosed by the present invention is patentably distinct from Douglas et al and would not be obvious to one skilled in the art. Accordingly, applicants respectfully submit that the claims as amended are patentable over the cited art and should be allowed.

Claim Rejections – 35 USC § 103

Claims 26, 34, 36, 37, 40, 42-45 and 48-50 were rejected under 35 U.S.C. 103(a) as being unpatentable over Douglas et al in view of Ranade et al (US 5,928,405). The applicants will swear behind Rande et al. Accordingly, the applications respectfully submit that the claims as currently amended are patentable over Ranade et al.

Claims 26, 34, 36, 37, 40, 42, 48 and 50 were rejected under 35 U.S.C. 103(a) as being unpatentable over Douglas et al in view of Schmidberger et al (US 4,396,420). The applicants respectfully traverse this rejection.

Schmidberger et al teach a method for making Ag / metal oxide particles with diameters in the range of 1 – 10 microns (see column 2, lines 44-46) wherein the particles have individual metal oxide grains with dimensions of less than 1 micron (see column 2, lines 46-47). Schmidberger et al makes a clear distinction between the size of the composite particles and the size of the metal oxide precipitate grains. The present invention teaches advantages related to average diameters of less than about 1 micron for specific particles, not particles' constituent grains.

The new art disclosed by the present invention is patentably distinct from Schmidberger et al in light of Douglas and would not be obvious to one skilled in the art. Accordingly, applicants respectfully submit that the claims as amended are patentable over the cited art and should be allowed.

Claims 27, 35 and 41 were rejected under 35 U.S.C. 103(a) as being unpatentable over Douglas et al in view of Yamada et al (US 4,173,518). The applicants respectfully traverse this rejection.

Yamada et al teach the use of aluminum reduction electrodes made of or coated with particular mixed-metal oxide materials. Yamada et al teach that the oxide electrodes or oxide-coated electrodes (e.g. oxide-coated carbon electrodes) resist oxidation when immersed in molten salts. Yamada et al teach directly depositing solid oxide coatings by flame spraying, plasma spraying and electroplating (column 7, lines 14-16), and report depositing oxide coatings using plasma spraying of semi-molten oxide granules (see, for example, column 11, lines 5-11). Yamada et al also teach two-step deposition of solid oxide coatings by first depositing (e.g. by dipping, spraying, thermal decomposition, etc.) a precursor coating comprising a metal and subsequently sintering the precursor coating to convert the precursor coating to a solid oxide coating (see column 7, lines 17-28), and report using a two-step process in which solid metal coatings were first deposited by electroplating and were then converted to oxides by oxidative sintering (see, for example, column 9, lines 11-21).

Neither of the methods taught by Yamada et al for forming solid oxide coatings involves direct formation of oxides from metal compounds, and neither of the methods taught by Yamada et al suggests the direct aerosol pyrolysis method of forming specialized fine powders taught by the present invention. Even one skilled in the art would not have arrived at the present invention by combining the solid coatings deposition methods taught by Yamada et al with the powder formation method taught by Douglas et al. For example, neither Yamada et al's first method of making gallium oxide coatings by plasma spraying using gallium oxide granules, nor Yamada et al's second method of, say, electroplating a Ga precursor coating and then oxidizing the

metallic precursor coating to form an oxide coating would likely be combined with the Douglas et al method of making oxide particles directly from reactant solutions via aerosol pyrolysis to arrive at the direct powder processes taught by the present invention.

The new art disclosed by the present invention is patentably distinct from Yamada et al in light of Douglas et al and would not be obvious to one skilled in the art. Accordingly, applicants respectfully submit that the claims as amended are patentable over the cited art and should be allowed.

Claims 30-32 and 36 were rejected under 35 U.S.C. 102(e) as anticipated by or, in the alternative under 35 U.S.C. 103(a) as obvious over Asada et al (US 5,964,918). The applicants respectfully traverse this rejection.

Asada et al teach an aerosol pyrolysis method of preparing a metal powder in which the surface of the metal powder is in part coated with another material. The method of Asada et al involves mixing multiple metal-containing reactants together in a common solution, atomizing the solution into droplets, and heating the droplets to form powder in which the multiple metals automatically segregate into a particle comprising the "major metal" and a surface deposit comprising the "metal or the like", e.g. a solution comprising Ag- and Ni-containing reactants reacted to form Ag powder with Ni oxide on the surface (see column 4, lines 59-64). All of the examples given by Asada et al involve Ag or Ag-Pd as the "major metal". While the present inventors believe that it is likely that the method of Asada et al works only for select noble metals (e.g. Ag and Pd) in which select secondary metals will segregate as oxides (e.g. Cu & Ni) or metals (e.g. Rh), Asada et al teach that the method is also applicable to major metals selected from the base metals including Cu and Al (see column 2, lines 39-41). For all "major metal" choices, Asada et al teach that the "metal or the like" not melt under conditions for forming the powder and that the "metal or the like" not hardly dissolve in solid solution form in the powder (see column 2, lines 53-58).

The applicants respectfully submit that the claims as amended are limited to materials that do not meet the criteria of Asada et al, namely the metals groups defined in claim 30 as currently amended do not meet the melting and/or dissolution criteria defined by Asada et al, and hence the present invention is not anticipated by or obvious over Asada et al.

The new art disclosed by the present invention is patentably distinct from Asada et al and would not be obvious to one skilled in the art. Accordingly, applicants respectfully submit that the claims as currently amended are patentable over the cited art and should be allowed.

Conclusion

For all of the above reasons, applicants submit that the claims are now in proper form, and that the claims all define patentably over the prior art. Therefore they submit that this application is now in condition for allowance, which action they respectfully solicit.

Conditional Request for Constructive Assistance

Applicants have amended the claims of this application so that they are proper, definite, and define novel matter that is also unobvious. If, for any reason this application is not believed to be in full condition for allowance, applicant respectfully requests the constructive assistance and suggestions of the Examiner pursuant to M.P.E.P. §706.03(d) and § 707.07(j) in order that the undersigned can place this application in allowable condition as soon as possible and without the need for further proceedings.

The applicants can be reached by telephone at (805) 987-7258.

Very Respectfully,

Chris Eberspacher

Karen L. Pauls

-------------------------------------- Applicants Pro Se --------------------------------------

c/o UNISUN
587-E North Ventu Park Road, PMB 124
Newbury Park, CA 91320
Tel. (805) 987-7268 ; Fax (805) 987-7268 ; e-mail: "UNISUN@aol.com"